TITLE

EXHAUST GAS FLOW CIRCUIT AND DECHARGE UNIT FOR AN INTERNAL COMBUSTION ENGINE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U. S. Provisional Application No. 60/439,676, filed January 13, 2003.

BACKGROUND OF THE INVENTION

The present invention relates generally to naturally aspirated internal combustion engines and, in particular, to a decharge unit to improve low-end torque at wide open throttle for a naturally aspirated engine.

A continuing goal for naturally aspirated engines is to improve low-end torque. Common methods for improving low-end torque involve installing a turbocharger or a supercharger in the engine intake system. The use of these devices, however, leads to high after-boost air temperature. An intercooler is then required to bring the air temperature down to a more manageable temperature. In addition, by installing a turbocharger or supercharger, the engine is no longer naturally aspirated. Another problem is that of back pressure, or the pressure in the exhaust system that the engine must overcome in order for the exhaust gas to flow through the exhaust system to atmosphere. Turbochargers and superchargers located in the intake system do not address the engine exhaust system back pressure. In addition, such turbochargers and superchargers are expensive, and require modifications to both the exhaust system and the intake system of the engine.

It is desirable, therefore, to provide a means for improving the low end torque for a naturally aspirated engine by reducing the back pressure of the exhaust system. It is also desirable to improve the low end torque of an internal combustion engine using inexpensive components that do not require any modification to the intake system of the engine.

SUMMARY OF THE INVENTION

An exhaust gas flow circuit according to this invention reduces back pressure in the exhaust gas system of an internal combustion engine, increases the mass flow rate of fresh air into the combustion cylinders, provides good scavenging in the combustion cylinders, and decreases the work required to pump exhaust gas from the engine through the exhaust system.

An exhaust gas flow circuit according to this invention includes a pumping unit, such as a gas compressor, for pumping exhaust gas from the engine exhaust system through an inlet to an outlet. A power source, such as an electric motor, drives the pumping unit. A bypass passage is arranged in parallel flow relation with the pumping unit between the inlet and outlet. When the mass flow rate of exhaust gas is relatively high, a bypass valve opens the bypass passage, providing a flow path for exhaust gas between the inlet and outlet in parallel with the pumping unit. When the mass flow rate of exhaust gas is relatively low, the bypass valve closes the bypass passage. The bypass valve can be controlled to open and close in response to engine speed, which is a measure of the exhaust gas mass flow rate.

The pumping unit and motor may be enclosed in a heat resistant housing to protect them from the high temperature environment of the exhaust system.

DESCRIPTION OF THE DRAWING

The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings in which:

Fig. 1 is a schematic diagram of a decharge unit for a naturally aspirated engine in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Fig. 1, a decharge unit in accordance with the present invention is indicated generally at **10**. The decharge unit **10** is disposed in an exhaust system, indicated generally at **12**, of an internal combustion engine **14**. The engine **14** includes a plurality of combustion cylinders **16**, each of which is connected by an intake pipe **18** to

an intake plenum **20**. The intake plenum **20** is connected at an open end to an air filter **21**. Each of the combustion cylinders **16** is connected by an exhaust manifold **22** to the exhaust system **12**. The exhaust system **12** includes a first catalytic converter or catalyst device **24,** connected at an inlet thereof to the exhaust manifold **22**. An inlet of a second catalyst device **26** is connected to an outlet of the first catalyst device **24**. An outlet of the second catalyst device **26** is connected by an exhaust pipe **27** to an inlet **28** of the decharge unit **10**. The first catalyst device **24**, the second catalyst device **26** and the exhaust pipe **27** form a first or forward portion of the exhaust system **12**.

The inlet **28** of the decharge unit **10** is connected to an inlet of a gas compressor or gas pump **30**. The compressor **30** is preferably a heat resistant compressor that is able to withstand the heat of the exhaust gas, discussed in more detail below. The compressor **30** is powered by an electric motor **32**, which is connected to an electrical power source (not shown). An outlet of the compressor **30** is connected to an outlet **34** of the decharge unit **10**, which is connected to a discharge pipe **36**. The discharge pipe **36** extends to a conventional rear exhaust system **44** that includes an exhaust muffler and exhaust outlet. A bypass passage **38** extends between the discharge pipe **36** and the exhaust pipe **27**. A bypass valve **40** is disposed in the bypass passage **38**. Preferably, the decharge unit **10** is disposed in a housing **42** in order to protect the compressor **30** and the electric motor **32** from corrosion and possible foreign object damage. The discharge pipe **36** and rear exhaust system **44** form a second or rearward portion of the exhaust system **12**.

In operation, air is inducted into the engine combustion cylinders **16** through the air filter **21**, inlet plenum **20**, and inlet piping **18**. When the engine **14** is operated normally, air is mixed with fuel (not shown), and the air-fuel mixture is compressed by a piston (not shown), located in each combustion cylinder **16,** and ignited, thereby producing exhaust gas. The exhaust gas is routed through the exhaust manifold **22**, the first and second catalyst devices **24, 26** and to the inlet **28** of the decharge unit **10**.

The compressor **30** of the decharge unit **10** pumps the exhaust gas from the exhaust system **12** to the rear exhaust system **44,** thereby reducing the back pressure in the exhaust system **12** when the engine **14** is operating. When engine speed is relatively low, the bypass valve **40** is closed. When the operating speed of the engine **14** is relatively high and the engine is producing a larger exhaust gas mass flow rate than at low engine speed, the bypass valve **40** is opened. Then at least a portion of the exhaust

gas bypasses the decharge unit **10** so that the decharge unit **10** does not increase the back pressure of the exhaust system **12**. The electric motor **32** can be turned on and off with a control signal received on a line **46**. The control signal on the line **46** can be generated in any known manner based upon, for example, sensing the engine speed or the mass flow rate of the exhaust gas in the exhaust system **12**.

By decreasing the back pressure in the exhaust system **12**, the decharge unit **10** according to the present invention increases the mass flow of fresh air into the combustion cylinders **16**, achieves good scavenging of the combustion cylinders **16**, and decreases the amount of pumping work of the engine **14**.

In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope.